Original Research Article

Impact of Plant geometry and Zinc on Growth and Yield Attributes of Sweet corn (*Zea mays* L.)

Abstract

During Zaid 2021, a field experiment was undertaken at the Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P). The experiment was set up using a Randomized Block Design, with nine treatments reproduced three times over the course of a year. The treatments which are T_1: 40cm x 20 cm + 15 kg/ha $ZnSO_4$, T_2: 40cm x 20 cm + 20 kg/ha $ZnSO_4$, T_3: 40cm x 20 cm + 25 kg/ha $ZnSO_4$, T_4: 50cm x 20 cm + 15 kg/ha $ZnSO_4$, T_5: 50cm x 20 cm + 20 kg/ha $ZnSO_4$, T_6: 50cm x 20 cm + 25 kg/ha $ZnSO_4$, T_7: 60cm x 20 cm + 15 kg/ha $ZnSO_4$, T_8: 60cm x 20 cm + 20 kg/ha $ZnSO_4$, T_9: 60cm x 20 cm + 25 kg/ha $ZnSO_4$ used. The results showed that application of 60cm x 20 cm + 25 kg/ha $ZnSO_4$ was recorded significantly highest plant height (166.02 cm), Number of leaves/plant (12.25), Dry weight/plant (141.58 g/plant), no. of cobs/plant (1.76), length of the cob/plant (16.90 cm), Cob girth (15.46 cm) whereas maximum crop growth rate (48.65 g/m^2/day) was recorded with treatment 40cm x 20 cm + 25 kg/ha $ZnSO_4$ whereas, cob yield (9.45 t/ha) and Green fodder yield (20.55 t/ha) recorded maximum in 40cm x 20 cm + 25 kg/ha $ZnSO_4$. However, higher gross returns (Rs.1,82,025.00/ha), net returns (Rs.1,22,288.60/ha) and B:C ratio (2.04) obtained with application 40cm x 20 cm + 25 kg/ha $ZnSO_4$ as compared to other treatments.

***Key words*:** Plant Geometry, Zinc, growth, yield, and Sweet Corn.

INTRODUCTION

Maize, a member of the Poaceae family, is a major cereal food grain crop grown in more than 166 nations throughout the world, encompassing tropical, sub-tropical, and temperate climates. There is no other cereal on the planet with such a large output potential as maize, which has earned it the title of "Queen of Cereals." Sweet corn (*Zea mays*

Saccharata) cultivated effectively for vegetable purpose in several countries including USA, Canada, Thailand, Taiwan, Indonesia and India where it is widely grown. In the food industry, the term "sweet corn" is often used. It's a new economic maize variety with greater sugar content in green cobs (14-20%).

Zn influences the activities of hydrogenase and carbonic anhydrase, as well as the stabilization of ribosomal proteins, in plant metabolism (**Tisdale *et al*., 1995**). For its physiological requirements, maize has the highest sensitivity to Zn shortage among crops. Zinc activates plant enzymes through glucose metabolism, preserving cellular membrane integrity, protein synthesis, and auxin production regulation **(Marschner 1995**). Zinc affects a variety of functions, including photosynthesis, defence against reactive oxygen species, nitrogen metabolism, carbonic anhydrase activity, chlorophyll synthesis, and tolerance to biotic and abiotic stressors **(Monreal *et al*., 2015).**

One of the most significant aspects for higher production is optimal plant population, which allows for optimum use of subsurface resources as well as maximum solar radiation harvesting, which leads to improved photosynthesis **(Monneveux *et al*., 2005**). There is an ideal plant population for maximum economic output for all agricultural species, which varies by cultivar and habitat **(Bruns and Abbas, 2005)**. Plant density increases yield for a corn genotype farmed under a set of specific environmental and management conditions up to a point, then decreases as plant density is increased further **(Gozobenli *et al*., 2004).**

MATERIALS AND METHODS

This experimental trial was carried out at the Crop Research Farm (CRF), Department of Agronomy, Sam Higginbottom University of Agriculture, Technology & Sciences (SHUATS), Prayagraj (U. P), which is located at 25^0 39" 42" North latitude, 81^0 67" 56" East longitude, and 98 metres above mean sea level during Zaid 2021. The experiment was set up in a Randomized Block Design with nine different treatments and it consists of 27 plots *viz.*, T_1: 40cm x 20 cm + 15 kg/ha $ZnSO_4$, T_2: 40cm x 20 cm + 20 kg/ha $ZnSO_4$, T_3: 40cm x 20 cm + 25 kg/ha $ZnSO_4$, T_4: 50cm x 20 cm + 15 kg/ha $ZnSO_4$, T_5: 50cm x 20 cm + 20 kg/ha $ZnSO_4$, T_6: 50cm x 20 cm + 25 kg/ha $ZnSO_4$, T_7: 60cm x 20 cm + 15 kg/ha $ZnSO_4$, T_8: 60cm x 20 cm + 20 kg/ha $ZnSO_4$, T_9:

60cm x 20 cm + 25 kg/ha $ZnSO_4$ replicated thrice to determine the Impact of Plant geometry and Zinc on Growth and Yield Attributes of Sweet corn. The trail plot's soil was sandy loam in texture, pH (7.1), low in organic carbon (0.72 percent), available N (278.48 kg/ha), and medium in available P and K (27.80 kg/ha and 233.24 kg/ha, respectively). To meet the nitrogen, phosphorous, and potassium requirements, the research plot used urea, DAP, and MOP as nutrient sources. 120 kg N, 60 kg P2O5, 40 kg K2O/ha is the recommended dose. Zinc was given in the form of $ZnSO_4$ and according to the treatment protocol. From germination until harvest, many plant growth variables were recorded at equal intervals, and several yield metrics were recorded after harvest. Plant height (cm), number of leaves/plant, and Dry weight (g/plant) were measured as growth parameters, while yield parameters like cobs/plant, cob length/plant (cm), girth of cob (cm), Cob yield (t/ha), and Green fodder yield (t/ha) were measured and statistically analysed using analysis of variance (ANOVA) as applied to Randomized Block Design **(Gomez, K. A. and Gomez, A. A. 1984).**

Result and Discussion

GROWTH PARAMETERS OF SWEET CORN

Plant height

Significantly Highest plant height (166.02 cm) observed in the treatment with 60cm x 20 cm + 25 kg/ha $ZnSO_4$ over all the other treatments. However, the treatments with application of 50cm x 20 cm + 25 kg/ha $ZnSO_4$ (164.47 cm) and 60cm x 20 cm + 20 kg/ha $ZnSO_4$ (165.11 cm) which were found to be at par with treatment 60cm x 20 cm + 25 kg/ha $ZnSO_4$ as compared to all the treatments. Plant height was reduced when row spacing was reduced from 60 cm to 40 cm, owing to increased competition within the plants in closer spacing versus wider spacing. With low and medium row spacing, competition for space, light, nutrients, and moisture inside the intra-row plants was at its peak, resulting in a fall in stem girth thickness. Natural shadowing due to overcrowding of plants appears to have lowered the availability of light within the crop canopy and prevented elongation of lower internodes, resulting in a considerable drop in plant growth with decreasing row spacing. The findings were very similar to those of **Neupane *et al.* (2011**). The involvement of micronutrients in several physiological processes such as enzyme activation, electron transport, chlorophyll production, stomatal regulation, and others could explain the increase in plant height. Plant height increased as zinc levels increased, which could be owing to enhanced photosynthetic activity and chlorophyll production as a result of zinc fertilization, resulting in improved vegetative development. According to **Arab *et al***., the outcomes were as expected (**2018**).

No. of Leaves/Plant

Highest Number of leaves per plant (12.25) was observed in the treatment with application of 60cm x 20 cm + 25 kg/ha $ZnSO_4$, which was significantly higher than the other treatments. However, the treatments with 50cm x 20 cm + 25 kg/ha $ZnSO_4$ (12.07) and 60cm x 20 cm + 20 kg/ha $ZnSO_4$ (12.14) which were found to be statistically at par with 60cm x 20 cm + 25 kg/ha $ZnSO_4$. The number of leaves increased as zinc levels climbed and dropped as zinc levels fell. Increased cell division, absorption rate, and metabolic activities in the plant could explain the larger number of functioning leaves under higher fertilizer levels. The current findings are in line with **Tariq *et al.*** findings. .'s (**2014**).

Plant dry weight (g/plant)

Treatment with 60cm x 20 cm + 25 kg/ha $ZnSO_4$ was recorded with significantly maximum dry weight (141.58 g/plant) over all the treatments. However, the treatments with 50cm x 20 cm + 25 kg/ha $ZnSO_4$ (141.00 g/plant) and 50cm x 20 cm + 25 kg/ha $ZnSO_4$ (140.20 g/plant) which were found to be statistically at par with 60cm x 20 cm + 25 kg/ha $ZnSO_4$. Dry matter accumulation increased from 20 to 80 DAS due to availability of higher sunshine and CO_2 under spacing of 60 x 20 cm might have resulted in higher photosynthetic productivity than 50 x 20 and 40 x 20 cm spacing. This was evident from more dry matter accumulation under spacing of 60 x 20 cm followed by 50 x 20, 40 x 20 cm spacing. Similar results were reported by **Sumeria *et al.* (2007).** The highest of biomass increase was observed because of increasing levels of zinc. Although the application of zinc as basal dose to sweet corn increased its dry matter significantly, Long plant height, high stem girth, and high root weights result in high dry matter under those treatments. **Palai *et al.* (2018)**.

Table 1: Impact of Plant geometry and Zinc on Growth parameters of Sweet corn.

	Treatment	Plant height (cm)	Number of leaves/plant	Dry weight (g/plant)
1	40cm x 20 cm + 15 kg/ha $ZnSO_4$	159.60	11.63	136.83
2	40cm x 20 cm + 20 kg/ha $ZnSO_4$	160.38	11.72	137.31
3	40cm x 20 cm + 25 kg/ha $ZnSO_4$	162.60	11.85	138.38
4	50cm x 20 cm + 15 kg/ha $ZnSO_4$	161.45	11.79	137.77
5	50cm x 20 cm + 20 kg/ha $ZnSO_4$	163.30	11.98	139.11
6	50cm x 20 cm + 25 kg/ha $ZnSO_4$	164.47	12.07	140.20
7	60cm x 20 cm + 15 kg/ha $ZnSO_4$	162.85	11.91	138.92
8	60cm x 20 cm + 20 kg/ha $ZnSO_4$	165.11	12.14	141.00
9	60cm x 20 cm + 25 kg/ha $ZnSO_4$	166.02	12.25	141.58
	S. Em (±)	0.53	0.09	0.54
	CD (p=0.05)	1.62	0.27	1.56

Impact on yield parameters of Sweet corn

Significantly Maximum Number of cobs/plant (1.76) was recorded with the treatment of application of 60cm x 20 cm + 25 kg/ha $ZnSO_4$ over all the treatments. However, the treatments 50cm x 20 cm + 25 kg/ha $ZnSO_4$ (1.68) and 60cm x 20 cm + 20 kg/ha $ZnSO_4$ (1.73) were found to be statistically at par with 60cm x 20 cm + 25 kg/ha $ZnSO_4$. Zinc influences the activity of growth enzymes, as well as glucose metabolism, cellular membrane integrity, protein synthesis, and regulation of auxin synthesis and pollen development, all of which contribute to a higher number of cobs. The findings were found to be similar with **Anjum *et al.* (2017).**

Significantly highest length of cob/plant (16.90 cm) was recorded with the treatment 60cm x 20 cm + 25 kg/ha $ZnSO_4$ over all the treatments. However, the treatments 50cm x 20 cm + 25 kg/ha $ZnSO_4$ (16.57 cm) and 60cm x 20 cm + 20 kg/ha $ZnSO_4$ (16.73 cm) were found to be statistically at par with 60cm x 20 cm + 25 kg/ha $ZnSO_4$. Highest Girth of the Cob (15.46 g) was recorded with the treatment application of 60cm x 20 cm + 25 kg/ha $ZnSO_4$ over all the treatments. However, the treatments with (15.16 g) in 50cm x 20 cm + 25 kg/ha $ZnSO_4$ and (15.27 g) in 60cm x 20 cm + 20 kg/ha $ZnSO_4$ which were found to be statistically at par with 60cm x 20 cm + 25 kg/ha $ZnSO_4$. The formation of photosynthates and their transfer to the sink require the availability of mineral nutrients, which has boosted zinc uptake. Higher chlorophyll content and seed treatment with biofertilizers caused the application of zinc, which had an apparent positive effect on photosynthetic activity, metabolite and growth-regulating substance synthesis, oxidation and metabolic activities, and ultimately better crop growth and development, which led to an increase in yield attributes. These results are similar to those of **Arab *et al*. (2018)** and **Naik *et al*. (2020).**

Significantly maximum cob yield (9.38 t/ha) was recorded with the treatment application of 40cm x 20 cm + 25 kg/ha $ZnSO_4$ over all the treatments. However, the treatments with (9.22 t/ha) in 40cm x 20 cm + 20 kg/ha $ZnSO_4$ and (9.18 t/ha) in 50cm x 20 cm + 25 kg/ha $ZnSO_4$ which were found to be statistically at par with and 40cm x 20 cm + 25 kg/ha $ZnSO_{4.}$ Less intra row spacing increases competition in solar radiation, which inhibits growth of some intra row plants in vegetative phase and prevents them from reaching reproductive phase, resulting in increased seed output under 40 x 20 cm compared to other treatments. Despite the fact that the yield influencing variables were higher than suggested spacing, productivity was poor due to the reduced plant population reaching reproductive phase**. Ariraman *et al*.** findings.'s were confirmed (2021). Zinc supplementation to sweet corn crops promotes fruit growth by promoting the synthesis of tryptophan and auxin. The enhancing effect on cobs/plants and their length and weight was linked to the beneficial effect of Zn treatment to crops on nutrient metabolism, biological activity, and growth parameters. As a result, zinc application resulted in taller and more active enzymes, which stimulated more cobs and increased cob production. Similar finding were reported earlier by **Naik *et al.* (2020).**

Significantly higher Green fodder yield (20.55 t/ha) was recorded with the treatment application of 40cm x 20 cm + 25 kg/ha $ZnSO_4$ over all the treatments. However, the treatments with (20.49 t/ha) in 40cm x 20 cm + 20 kg/ha $ZnSO_4$ and (20.35 t/ha) in 50cm x 20 cm + 25 kg/ha $ZnSO_4$ which were found to be statistically at par with and 40cm x 20 cm + 25 kg/ha $ZnSO_4$. Zinc is involved in various physiological processes in plants, including chlorophyll production, stomatal control, starch utilization, and biomass buildup, all of which contribute to increased green fodder supply. Zinc also contributes to crop yield by converting ammonia to nitrate. **Tamil Amutham *et al*.** have reported similar findings (**2018)**.

Table 2: Impact of Plant geometry and Zinc on Yield parameters and Yield of Sweet corn.

Treatments	No. of Cobs/Plant	Cob Length/Plant (cm)	Cob Girth/ Plant (Cm)	Cob yield(t/ha)	Green fodder yield (t/ha)
1. 40cm x 20 cm + 15 kg/ha $ZnSO_4$	1.31	15.37	14.48	8.54	20.02
2. 40cm x 20 cm + 20 kg/ha $ZnSO_4$	1.40	15.60	14.65	9.26	20.49
3. 40cm x 20 cm + 25 kg/ha $ZnSO_4$	1.51	16.00	14.83	9.45	20.55
4. 50cm x 20 cm + 15 kg/ha $ZnSO_4$	1.45	15.83	14.75	7.76	19.77
5. 50cm x 20 cm + 20 kg/ha $ZnSO_4$	1.61	16.30	15.00	8.83	20.26
6. 50cm x 20 cm + 25 kg/ha $ZnSO_4$	1.68	16.57	15.16	9.07	20.35
7. 60cm x 20 cm + 15 kg/ha $ZnSO_4$	1.55	16.13	14.94	7.16	19.57
8. 60cm x 20 cm + 20 kg/ha $ZnSO_4$	1.73	16.73	15.27	7.53	19.68
9. 60cm x 20 cm + 25 kg/ha $ZnSO_4$	1.76	16.90	15.46	8.22	19.94
S. Em (±)	0.03	0.15	0.11	0.13	0.07
CD (P = 0.05)	0.10	0.45	0.32	0.40	0.22

CONCLUSION

Based on the findings the investigation it may be concluded of treatment 40cm x 20 cm + 25 kg/ha $ZnSO_4$ performed exceptionally in obtaining higher cob yield of sweet corn. Hence, 40cm x 20 cm + 25 kg/ha $ZnSO_4$ is beneficial under U.P Conditions**.**

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